Geologic Resource Evaluation Scoping Summary
Abraham Lincoln Birthplace National Historic Site

Geologic Resources Division
National Park Service
US Department of the Interior

The Geologic Resource Evaluation (GRE) Program provides each of 270 identified natural area National Park Service units with a geologic scoping meeting, a digital geologic map, and a geologic resource evaluation report. Geologic scoping meetings generate an evaluation of the adequacy of existing geologic maps for resource management, provide an opportunity for discussion of park-specific geologic management issues and, if possible, include a site visit with local experts. The purpose of these meetings is to identify geologic mapping coverage and needs, distinctive geologic processes and features, resource management issues, and potential monitoring and research needs. Outcomes of this scoping process are a scoping summary (this report), a digital geologic map, and a geologic resource evaluation report.

The National Park Service held a GRE scoping meeting for Abraham Lincoln Birthplace National Historic Site on June 15, 2006 at Mammoth Cave National Park in Kentucky. Tim Connors (NPS-GRD) and Jim Chappell (Colorado State University) facilitated the discussion of map coverage and Bruce Heise (NPS-GRD) led the discussion regarding geologic processes and features at the site. Participants at the meeting included NPS staff from the park, Geologic Resources Division, Kentucky Geological Survey, Cumberland Piedmont Network, as well as area experts from the Cave Research Foundation, State University of New York, and Kentucky University, and cooperators from Colorado State University (see table 2). This scoping summary highlights the GRE scoping meeting for Abraham Lincoln Birthplace National Historic Site including the geologic setting, the plan for providing a digital geologic map, a prioritized list of geologic resource management issues, a description of significant geologic features and processes, lists of recommendations and action items, and a record of meeting participants.

Park and Geologic Setting

Abraham Lincoln Birthplace National Historic Site was established as a national park on July 17, 1916 as part of the War Department. A cabin, similar to the one in which Lincoln was born, is preserved in a memorial building near the Sinking Spring at the main unit. The unit was transferred to the National Park Service on August 10, 1933 and redesignated a national historical park on August 11, 1939. The park was renamed and redesignated to its present status on September 8, 1959. Abraham Lincoln Birthplace National Historic Site is located on 344.50 acres in west-central Kentucky, ~4 km south of the town of Hodgenville (main unit) and ~4km northeast of White City (boyhood home unit, incorporated 1.5 years ago). The historic site (2 small units) sits entirely within the 7.5-minute Hodgenville quadrangle. The birthplace unit sits between McDougal Creek, and the South Fork and North Fork of the Nolin River, which is a tributary to the Green River, and the boyhood home unit is situated northeast of McDougal Creek along a small tributary of Rolling Fork in the hills of Cecil Ridge. The geology in this area consists of nearly flat-lying sedimentary rocks of Mississippian to Pennsylvanian age. The limestone-rich units are susceptible to karstic dissolution. The landscape of the site is characterized by low-lying rolling hills, numerous depressions, small sinkhole lakes and other karstic landscape features including sinkholes, disappearing creeks, and springs.

Geologic Mapping for Abraham Lincoln Birthplace National Historic Site

During the scoping meeting Tim Connors (NPS-GRD) and Jim Chappell (Colorado State University) showed some of the main features of the GRE Programs digital geologic maps, which reproduce all aspects of paper maps, including notes, the legend, and cross sections, with the added benefit of GIS compatibility. The NPS GRE Geology-GIS Geodatabase Data Model incorporates the standards of digital map creation set for the GRE Program. Staff members digitize maps or convert digital data to the GRE digital geologic map model using ESRI ArcMap software. Final digital geologic map products include data in geodatabase, shapefile, and coverage format, layer files, FGDC-compliant metadata, and a Windows HelpFile that captures ancillary map data.

When possible, the GRE program provides large scale (1:24,000) digital geologic map coverage for each park's area of interest, usually composed of the 7.5-minute quadrangles that contain park lands (figure 1). Maps of this scale (and larger) are useful to resource management because they capture most geologic features of interest and are positionally accurate within 40 feet. The process of selecting maps for management use begins with the identification of existing geologic maps and mapping needs in vicinity of the park. Scoping session participants then select appropriate source maps for the digital geologic data to be derived by GRE staff. Table 1 lists the source maps chosen for Abraham Lincoln Birthplace National Historic Site.

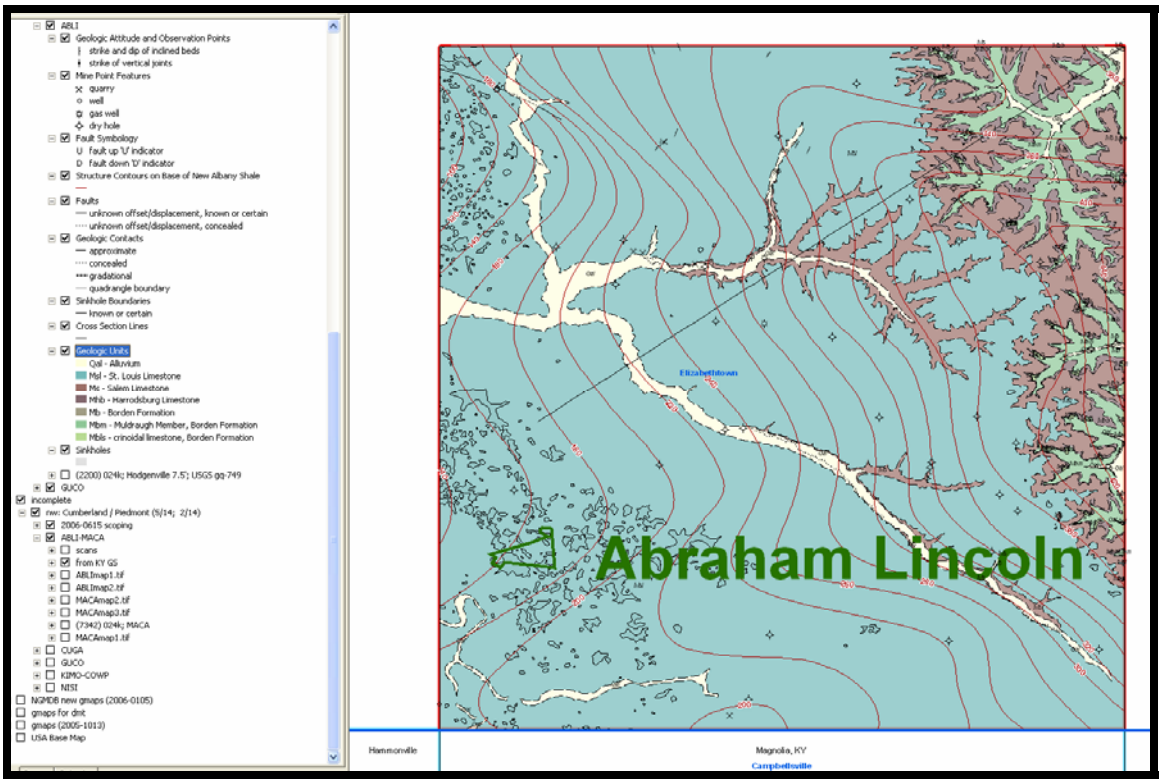
Table 1. GRE Mapping Plan for Abraham Lincoln Birthplace National Historic Site

Covered Quadrangles	GMAP[1] [1]	Citation	Scale	Format	Assessment	GRE Action
Hodgenville	2200	Moore, Frank B., 1968, *Geologic map of the Hodgenville quadrangle, Larue and Nelson Counties, Kentucky*, U.S. Geological Survey GQ-749, 1:24000 scale	24,000	Paper	Data is digital, but features may be missing in the digital data from the original paper map including cross section lines, mine features, geologic point features, etc.. GRE staff will discern and add missing map items either from KGS scans or GRE scans of the original paper map.	Convert to GRE Geodatabase-Data Model
	74448	Kentucky Geological Survey, 2006, *Digital Geologic map of the Hodgenville quadrangle, Larue and Nelson Counties, Kentucky*, Kentucky Geological Survey, Digitally Vectorized Geologic Quadrangle DVGA-749 , 1:24000 scale	24000	Digital		
N / A	74479	Paylor, Randall L., Florea, Lee, Caudill, Michael, and Currens, James C., 2003, *A GIS Sinkhole Coverage for the Karst areas of Kentucky*, Kentucky Geological Survey, unpublished, 1:24000 scale	24000	Digital	These are digital datasets from the state of Kentucky featuring statewide themes useful for resource management	Convert to GRE Geodatabase-Data Model
N / A	53392	Carey, D.I.;Nuttall, B.C., 1995, *Distribution of oil and gas wells in Kentucky*, Kentucky Geological Survey, Map and Chart Series MCS-11_009, 1:1000000 scale	1000000	digital		

[1]GMAP numbers are unique identification codes used in the GRE database.

Moore's (1968) map of the Hodgenville quadrangle was determined to be adequate for resource management at Abraham Lincoln Birthplace National Historic Site. The Kentucky Geologic Survey (KGS) scanned this map and digitized it at 1:24,000 scale for their 2005 spatial database. In accordance with their data model and digital product criteria, the KGS did not include cross section lines (or graphics), some mine features, several geologic point features, some water areas, etc. Thus GRE staff reviewed the paper maps and captured these features when they weren't present. Sinkhole, and Oil and gas features were captured in separate digital KYGS databases and were also converted to GRE formats

To this end, GRE staff have completed the conversion of these source maps and have posted them to the NPS NR GIS Data Store. A graphic of the completed ABLI geologic map is shown below.



A quick link to the digital geologic GIS files is as follows:

http://science.nature.nps.gov/nrdata/quickoutput.cfm?type=ds&cat=geology&key=GRE&parkcode=ABLI

Included are options for downloading as ESRI shapefile- ("ablishp.zip"), coverage- ("ablicov.zip") or personal geodatabase format ("abligdb.zip"). Supplied with the geodatabase format are the following "layers":

- Geologic attitude and observations points
- Mine point features
- Fault symbology

- Structure contours on the base of the New Albany Shale
- Faults
- Geologic contacts
- Sinkhole boundaries
- Cross section lines
- Geologic units
- sinkholes

Additional items of interest pertaining to geologic mapping from the scoping
The site has some interest in groundwater flow maps, additional fault mapping, and landuse planning maps (derivative product of the KGS).

Geologic Resource Management Issues

The scoping session for Abraham Lincoln Birthplace National Historic Site provided the opportunity to develop a list of geologic features and processes, which will be further explained in the final GRE report. During the meeting, participants prioritized the most significant issues as follows:

(1) Fluvial issues
(2) Mass wasting
(3) Disturbed lands
(4) Caves and karst
(5) Paleontological resources

Fluvial Issues

Fluvial issues at Abraham Lincoln Birthplace National Historic Site include flooding along the perennial stream at the main unit and flooding of Knob Creek at the boyhood home unit. The park contains significant portions of the floodplains of these waterways and park infrastructure is threatened.

The boyhood home unit contains an entire watershed (north branch of Knob Creek). The surrounding areas are largely forested and undeveloped. Preservation of high water quality is important to the site and understanding the hydrogeologic system is vital to this effort.

At the main birthplace unit, the natural sinking spring played a significant role in the historical development of the site. The site sits atop the Pennyroyal Plateau. Surface water on this karstic landscape is typically rare so in order to take advantage of the rich soil and agricultural opportunities, early settlers were drawn to areas with natural springs and sinkhole ponds. Lincoln's father settled at the site because of the ready access to water at the perennial spring.

Mass Wasting

There is some potential for slope creep and mass wasting at the historic site. The Borden Formation contains abundant clay and shale rich layers. There are new outcrops of this unit along the north branch of Knob Creek. This unit poses a problem when exposed along slopes and/or undercut. Rockfall is not likely at the park, but development of buildings, roads, and visitor use facilities must be careful situated on this geologic unit.

Disturbed lands

In the 1920's a structure was erected to alleviate a flood hazard posed by a seasonally ponded sinkhole. This infrastructure consists of a drain system of pipes, culverts (some of which are 1 m in diameter and are buried 3-4 m below ground). This system intended to coalesce runoff towards the natural spring. The structure was a failure and did not change the flood hazard at the site. Resource management might consider removing the structure and needs to understand any potential effects.

Quarries may exist within park boundaries for aggregate. Local quarries may affect the hydrologic system of the site.

Caves and karst

The sinking spring of the birthplace unit is a fundamental feature for the historic site. It is a key interpretive component as well. This karst feature has the potential, if the hydrogeologic system is not understood, to become a "stinking spring" due to increased contaminant presence in the area. The spring is a popular coin toss area for park visitors and pollution of the spring is possible. The spring is actually part of a karst window (a doline) fed by a perched aquifer located atop a local shale unit within the St. Louis Formation. This feature is traditionally part of the historical story at the site, but is in fact evidence of the pervasive karst processes at work on the landscape of the Pennyroyal Plateau. This spring also has cave potential upstream and should be managed as such.

The potential for sinkhole development is prevalent across the Pennyroyal Plateau. Weathered sinkholes define the regions rolling hill topography. Potential for sinkholes within park boundaries should be assessed. Knowledge of the subsurface caves and groundwater conduits would help this effort.

Paleontological resources

There are a few significant fossil localities at the site that have yet to be comprehensively studied or inventoried. Crinoids and other Mississippian age fossils in the Borden Formation are exposed in a cutbank across from a visitor use area at the boyhood home unit. The crinoids may be intact and show some color banding preservation. Knowledge of the extent of the paleontological resources in the area may also influence future expansion directions for the historic site.

Features and Processes

Karst processes are largely responsible for the landscape at Abraham Lincoln Birthplace National Historic Site. Because insoluble rocks such as sandstones, siltstones, and shales have been eroded off the top of the limestone-rich soluble layers, erosion and dissolution are pervasive. Insoluble rocks cap nearby topographically high areas such as the Chester Upland (Mammoth Cave National Park). The Pennyroyal Plateau is characterized by sinkholes, sinkhole ponds, small caves and springs such as the Sinking Spring located at the historic site. The landscape at the historic site is a testament to active karst processes of limestone dissolution, underground cavity development, spring activity, sinkhole collapse, and erosion.

Recommendations

(1) Perform groundwater trace studies to understand the flow of groundwater in the historic site and its immediate surrounding area
(2) Cooperate with the KGS to obtain land use planning maps (derivatives from the digital geologic map)
(3) Perform a comprehensive paleontological inventory of the historic site, especially focusing on outcrops of the Borden Formation near visitor use facilities. Establish a plan to deal with potential illegal sampling and collecting.
(4) After establishing baseline conditions (water quality, stream channel morphology, etc.), monitor changes to the north branch of Knob Creek's watershed to indicate any outside influences affecting the protected watershed.
(5) Investigate potential effects to watershed, spring, and landscape of removing 1920's era infrastructure designed (unsuccessfully) to alleviate flood hazard at birthplace unit.

(6) Determine if shrink-and-swell clays exist in the units at the site and avoid such areas for infrastructure development.
(7) Incorporate historical land use evolution and delineation studies and the effects of geology on the site's history into interpretive programs.

Action Items

(1) GRE needs to obtain the report generated from a small, GRD-funded karst project at the site.
(2) GRE will produce digital geologic map for the site (see above geologic mapping section).
(3) Site may be interested in the KGS land use planning maps derived by the KGS. Matt Crawford is an available contact for this information. Contact Bob Higgins (NPS-GRD) if interested.
(4) GRE report author needs to obtain the report generated during the construction of the 1920's failed drainage system.
(5) GRD (Tim Connors?) will contact Jason Kenworthy and/or Vince Santucci (both NPS) regarding a possible paleontological inventory for the site.

References

Palmer, A.N. 1981. *A geological guide to Mammoth Cave National Park*. Teaneck, NJ: Zephyrus Press.

Table 2. Scoping Meeting Participants

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